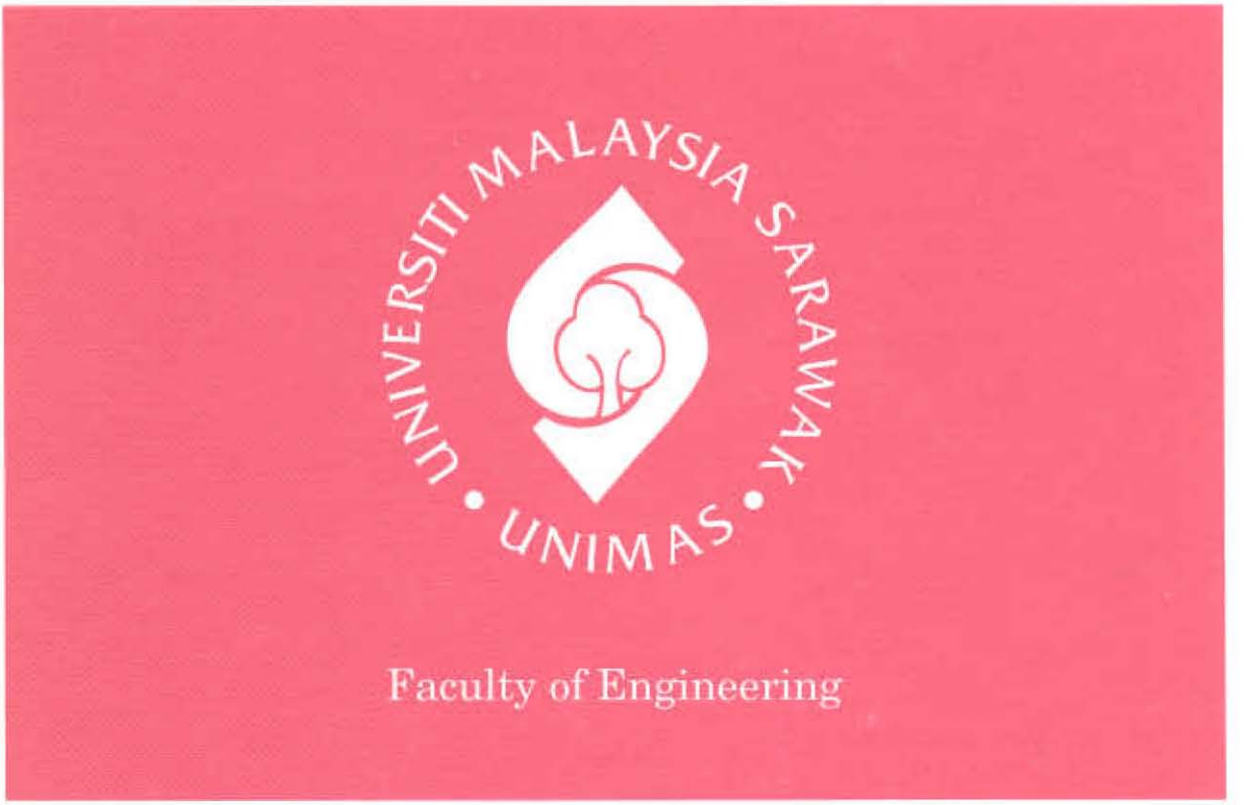

DRAINAGE AND LEAKAGE PREVENTION DESIGN FOR ULTRA MODERN LANDFILL DUMPSITE, MAMBONG, SARAWAK

Supian Bin Sulkar

Bachelor of Engineering with Honours
(Civil Engineering)
2004

DRAINAGE AND LEAKAGE PREVENTION DESIGN FOR ULTRA MODERN LANDFILL DUMPSITE, MAMBONG, SARAWAK

SUPIAN BIN SULKAR

This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Science with Honours
(Civil Engineering)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
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Universiti Malaysia Sarawak
Kota Samarahan

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BORANG PENYERAHAN TESIS

Judul: DRAINAGE AND LEAKAGE PREVENTION DESIGN FOR ULTRA MODERN LANDFILL DUMPSITE, MAMBONG, SARAWAK

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Tarikh: 30 march 2004

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(TANDATANGAN PENYELIA)

PROF. MADYA DR Ir F.J. PUTUHENA
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APPROVAL SHEET

This project report attached here to, entitled "DRAINAGE AND LEAKAGE PREVENTION DESIGN FOR ULTRA MODERN LANDFILL DUMPSITE, MAMBONG, SARAWAK" prepared and submitted by Supian Bin Sulkar in partial fulfillment of the requirements for the degree of Bachelor of Engineering (Civil) is hereby accepted.

1 April 2004

DR. Ir. F.J. PUTUHENA
Associate Professor
Civil Engineering Department
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Universiti Malaysia Sarawak

Date

Especially dedicated to
My beloved mother and father
My lovely fiancée
Thanks for everything
See me at the top

ACKNOWLEDGEMENT

Bismillahirrahmannirrahim.

In the name of Allah the Gracious and the Merciful.

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ABSTRAK

Pertambahan populasi setiap tahun khususnya di Bahagian Kuching berpotensi untuk mengakibatkan peningkatan kadar pembuangan sisa pepejal yang perlu diuruskan secara bijaksana. Pembuangan sisa pepejal, sisa berjadual dan sisa berbahaya yang dikumpul oleh pihak berkuasa tempatan dilupuskan di tapak pelupusan Matang dengan teknologi sedia ada. Namun demikian, kaedah pelupusan sisa pepejal yang ideal bukan sahaja memerlukan pelupusan secara fizikal, akan tetapi bahan sampingan terhasil dari sisa pepejal umpamanya larut lesap semasa hujan turut perlu diuruskan dengan sebaiknya. Larut lesap ini merupakan air hujan yang meresapi sisa pepejal yang terdedah, membawa pelbagai mineral terlarut termasuk logam berat. Isu-isu pencemaran yang kritikal akan timbul seandainya peresapan larut lesap ini ke dalam tanah tidak disekat dengan baik kerana mampu mencemari air bawah tanah seterusnya ke sumber aliran air berhampiran. Teknologi terkini dari German dalam mengawal larut lesap ini secara efektif adalah menerusi pengaplikasian lapisan TRISOPLAST® pada bahagian bawah tapak pelupusan yang aktif untuk tapak pelupusan baru di Mambong.

Penilaian terhadap rekaan untuk perparitan dan pencegahan kebocoran di tapak pelupusan Mambong telah dilaksanakan untuk pemahaman yang lebih baik, menyediakan dokumentasi rujukan yang sesuai dan dalam masa yang sama menjadi suatu bentuk pemindahan teknologi yang memerlukan pembelajaran lanjutan sama ada oleh para ilmiawan atau institusi-institusi tempatan. Beberapa penyelidikan terhadap rekaan perparitan luaran dan jarak pemisahan antara perpaipan untuk pengumpulan larut lesap telah dijalankan dalam bentuk pengiraan untuk tujuan

perbandingan. Sebagai tambahan, penerangan terperinci terhadap TRISOPLAST® turut dipertimbangkan untuk tujuan yang sama dan penerokaan lebih lanjut dalam menilai keefektifan rekaan dalam pencegahan kebocoran.

ABSTRACT

The yearly population increment focusing the Kuching Division is potentially resulting on the increment of solid waste dumping rate that need to be wisely handled. The collected municipal solid waste, scheduled and hazardous wastes by local councils are being disposed at Matang dumpsite running with former technologies. Nevertheless, the ideal solid waste disposal method is not only considering the physically disposal, but also the aside substances created such as the toxicity liquid (leachate) during rainfall, that need to be manage properly. Leachate is the rainfall water which infiltrating the exposed solid wastes, carrying out various dissolved minerals including heavy metals. Critical issues in environment may arise if the ground infiltration is weakly prevented because it may pollute the groundwater and thus to the nearest waterway resources. The latest technology from Germany in controlling leachate effectively is by the application of the TRISOPLAST® layer below the active landfill floor at the new site of Mambong.

Assessment of drainage and leakage prevention designs in Mambong landfill area have been conducted for better understanding, producing the proper reference documentations and at the same moment become a kind of transfer in technology that need the further studies carried out either by scholars or local institutions. Several cross examines of external drainage design and leachate collection pipelines spacing are being carried out in numerical for the purpose of comparison. In addition, detailed explanations of TRISOPLAST® are also considered for the same purpose and for further exploration in the effectiveness of leakage prevention design.

CHAPTER 1

INTRODUCTION

1.1 General Overview

As the time goes by, our daily life is getting smoother and better, proportional to the discoveries, developing and applications of science knowledge in inventing the new sophisticated technologies. Nevertheless the world nowadays is facing a very critical problem that is contributed by the increment of the world's population – rubbish heap problem.

From these reality facts, our Malaysian government is taking a few drastic actions as to wake up the Malaysian citizens so they will realize to love and appreciate the health and clean environments by emphasizing the recycle and reuse aspects through the long term campaign country-wide such as Recycling Campaign. The term *environment* has been defined as the conditions, circumstances and influences under which an organization or system exists. It may be affected or describe by physical, chemical and biological features, both natural and man-made. The environment is commonly used to refer to the circumstances in which man lives (Winpenny, 1991).

Millions of tones of solid wastes collected every month are become nearly uncontrollable and as the result, our existing landfill dumpsite's capacity is getting smaller and almost a perfect possibility of the dumpsite's age is below the early expectation.

Questioning of the effectiveness of the existing landfill dumpsite's technologies mainly covered the factors of the suitability of the location chose, the machineries used in managing the wastes and the long-terms management costs should have updated answers and effective solutions.

Consequently, the construction of the ultra modern landfill dumpsite with more environmental friendly characteristics and extra effective specifications should be considered seriously as a priceless alternative.

1.2 Major Criteria Concerned in Managing the Existing Dumpsite

Few numbers of criteria in the dumpsite's daily operation need to have extra attention as it is the sources in many minor problems. For instance, the odor that come from the toxically wastes or from the biodegrading process of the organic wastes. The possible sources are landfill gas, sludge, carcasses, putrescible wastes, leachate seeps, sulfides and mercaptans. The odor may be the irritating gases that will affect health in long-terms especially in lung disease. This problem can be controlled effectively by the placement and utilization of a horizontal gas collection system. Besides that, the covering method on the solid waste that reaches the decomposition stages can also help in reducing the odor's problem.

dangerous as they become the vectors in separating some diseases and contaminating the foods. The solution will need total elimination when necessary bay using the chemical poison.

Thus, the management of solid wastes is not only considering the sophisticated machines and techniques to guaranty the effectiveness, but those nature criteria discussed need to be controlled wisely to avoid mainly the community complaints.

1.3 Objectives

The solid waste that consists of municipal solid waste, scheduled and hazardous wastes are getting more serious as the time steps forward. It is a fearful condition if one day the solid wastes are going to fill up not only the existing dumpsites, but also the living places and no other effective solutions than starts to dump the wastes into the ocean. People around the world have been warned about this nightmare and the best action is to give full supports in any campaigns launched by the government and other related organizations.

At the same time, the involved organizations must have continuous efforts in exploring new advanced technologies that can be applied to hand the solid wastes dilemma. The main objective of this Final Year Project is to discover the new landfill liner technology from Germany in the solid waste management that will be introduce by the construction of the new ultra modern landfill dumpsite located at Mambong, Padawan. Besides that, the drainage system designs for the new landfill

also become the interests in this Final Year Project. This ultra modern landfill project consists of a few new imported technologies that are firstly applied in South East Asia region.

1.4 Scopes of Study

(a) Interest of having good studies in the new developing dumpsite area relates to the drainage and the leakage prevention design:

(i) The suitability and effectiveness of the design idea

(ii) The advanced criteria and comparison of the new liner technology with the former technologies and the drainage system design mainly for the sanitary and secure landfills area

(b) Studies on the conditions of the project site topography and the totally safe solid wastes disposal practiced:

(i) Nearest water sources and natural drainage

(ii) Internal drainage and liners to prevent leachate from seeping to the groundwater

(iii) The management of leachate outflow before the required standard treatment execute

(c) Exploring the positive and negative views in applying this new ultra modern landfill dumpsite in tropical country like Malaysia due to the drainage and leakage prevention design and the recommendations for future planning:

(i) Advantages and the disadvantages of the applied new liner technology due to the tropical weather and local conditions

(ii) The internal and external drainage patterns and dimensions with their suitability to satisfy the hydrological criteria of the project area

CHAPTER 2

LITERATURE REVIEW

2.1 Project Definition

The Final Year Project entitled as *Drainage and Leakage Prevention Design for Ultra Modern Landfill Dumpsite, Mambong, Sarawak* is the proposed selected title that is according to the information from the articles on the local daily newspapers. The term *ultra modern* refers to the application of the new advanced sealing technology entitled TRISOPLAST® and the two sophisticated plants for the purposes of treatment and controlling (Leachate Treatment Plant and Incineration Plant). This term is based on the comparison with the *modern landfill* phrase which is defined as the landfill dumpsite with the applied former sealing materials technology.

Nevertheless the exact title of the project is known as *Kuching Integrated Waste Management Park.* The park is divided into three major components in operation that are sanitary landfill area, secure landfill area and incineration plant area. The park is also equipped with Leachate Treatment Plant and Incineration Plant to ensure the environment issues are always on top in consideration during operational phase because the center is seriously deal with gigantic amount of wastes categorized as municipal solid wastes, scheduled and hazardous wastes.

2.2 Project Description

Overall project area is covering approximately 112 hectares including 50 meters wide buffer zone with a life-span of at least 20 years, which responsible for Kuching City municipal wastes and scheduled hazardous wastes in Sarawak. The implementation of this Ultra Modern Landfill Dumpsite project is responsible to Sarawak Wastes Management Sdn. Bhd. through their subsidiary, Trienekens (Sarawak) Sdn. Bhd. The landfill consisted of three main components briefly described as below:

(a) Sanitary Landfill

The sanitary landfill area covered approximately 32 hectares which is prepared for the allocation of municipal solid waste disposal. It is estimated that an amount of 400 metric tones of municipal solid waste per day can be collected from the councils for Kuching Division which are Majlis Bandaraya Kuching Selatan (MBKS), Dewan Bandaraya Kuching Utara (DBKU) and Majlis Perbandaran Padawan (MPP).

Sanitary landfill is having a total amount of eight small components and is divided into variable sizes that are depending on the topographical criteria of the selected area. Each component will have a life-span of more than two years. The landfill is equipped with leachate treatment facilities, seepage control facilities, leachate collection pipes and surface water / percolation collection ponds.

In addition, the expected operating life of all sanitary landfills area should be around 25 years calculated based on the data from the Environmental Impact Assessment (EIA) Report of the project represented as follow:

(i) Estimation on total amount of municipal solid waste generated for Kuching Division = 140,000 metric tones per year

(ii) Assumption on the density of municipal solid waste = 1 metric tone / m^3

(iii) Volume consumption of solid waste = 140,000 m^3

(iv) Estimated annual Kuching population growth rate = 3.5 %

(v) Total capacity of sanitary landfill = Approximately 4.5 million m^3

Liner system constructed beneath the cell's floor is designed based on the layer that consists of:

(i) Filtering layer with percolation coefficient, k_f of at least 2 x 10^{-3} m/s – 50 centimeters thickness

(ii) TRISOPLAST® layer (hydraulic conductivity, K = 5.6 x 10^{-8} cm/s) – 10 centimeters thickness

(iii) Geological barrier

(b) Secure Landfill

In landfill dumpsite, it is necessary to prepare the secure landfill area for the disposal of scheduled and hazardous wastes all over Sarawak. Some sources that generate hazardous wastes are from industrial zone, hospital, biochemical laboratory or even from universities. The total area allocated at Mambong landfill for secure landfill purpose is approximately covered 2.25 hectares with four sub-components prepared for disposal operation. The secure landfill is estimated to have an operating life of about 30 years based on the calculation with the following data acquired from the EIA Report of the project:

(i) Estimation on total amount of scheduled and hazardous wastes generated for Sarawak = 7,000 – 10,000 metric tones per year

(ii) Assumption on the density of scheduled and hazardous wastes = 1 metric tone per m^3

(iii) Volume consumption of scheduled and hazardous wastes = 5,400 m^3

(iv) Estimated annual scheduled and hazardous wastes generate rate for Sarawak = 3.5%

(v) Total capacity of sanitary landfill = Approximately 343,000 m^3

The design of secure landfill liner system is represented as below:

(i) Filtering layer with percolation coefficient, k_f of at least 2 x 10^{-3} m/s = 50 centimeters thickness

(ii) Composite of TRISOPLAST® layer and a layer of geomembrane, (hydranlic conductivity, K = 8.7 x 10^{-8} cm/s) – 20 centimeters thickness respectively

(iii) Geological barrier